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Cement Sidewalks

How to Lay a Walk that Will Wear Well

Practical Hints for the Beginner and
for the Experienced
Worker

Compiled by the Concrete Publishing Co.

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Preface. pam

Early in the fall of 1907 the Concrete Publishing Co. undertook to put into book form the answers to numerous requests for information on the subject of cement sidewalks, that reached the editor. The text in the first edition was largely made up of the experiences of others and the edition itself was issued more or less as an experiment. The immediate and widespread demand for the little books necessitated reprinting larger editions in January, July and December of 1908, but the demand has increased and the present edition has been prepared in answer to it.

Every effort has been made to keep the text clear and simple in phraseology; to leave out everything but the essential things; to cover the field as fully as possible; and to give the readers of the booklet the benefit of the experience of a large number of practical workers. We take this opportunity to express our thanks to those men in the industry who have so cheerfully co-operated with us in making it possible for us to issue our sidewalk booklet in its present form.

This is a small book—small because we have made it so, with the idea that what our friends want is not a bulky volume with the points buried, but a clear, concise, handy book of reference, containing all the information of more pretentious books, boiled down to the last degree of brevity.

Detroit, Mich., Feb. 1, 1909.

Cement Sidewalks



PROPOSED STANDARD SPECIFICATIONS FOR PORTLAND CEMENT SIDEWALKS.

(N. A. C. U., 1909.)

The specifications printed below are those amended by the convention at the Cleveland meeting of the National Association of Cement Users, January 12 to 16, 1909. Following the rules of the Association, they will be submitted to letter ballot and formally adopted by the organization, unless a sufficient number of the members declare against them. In their present form, the specifications present a number of important advances over the regulations made last year. It is believed that they are representative of the most approved modern practice and that sidewalks laid in accordance with their provisions will give entire satisfaction.

Following the specifications, we print our own comments on different phases of sidewalk construction that are not explained in detail in the specifications themselves.

Materials.

The cement shall meet the requirements of the specifications for Portland cement of

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the American Society for Testing Materials, ~~adopted by this Association~~ (Specification No. 1), January, 1906.

Aggregates.

Fine aggregate shall consist of sand, crushed stone, or gravel screenings, graded from fine to coarse, passing when dry a screen having $\frac{1}{4}$ -in. diameter holes, shall preferably be of silicious materials, clean, coarse, free from vegetable loam or other deleterious matter, and not more than 6 per cent shall pass a sieve having 100 meshes per linear inch.

Mortars composed of one part Portland cement and three parts fine aggregate by weight when made into briquets shall show a tensile strength of at least 70 per cent of the strength of 1:3 mortar of the same consistency made with the same cement and standard Ottawa sand.

Coarse aggregate shall consist of inert material, graded in size, such as crushed stone, or gravel, which is retained on a screen having $\frac{1}{4}$ -in. diameter holes, shall be clean, hard, durable, and free from all deleterious materials. Aggregates containing soft, flat or elongated particles, shall be excluded.

The maximum size of the coarse aggregate shall be such that it will not separate from the mortar in laying and will not prevent the concrete fully filling all parts of the forms. The size of the coarse aggregate shall be such as to pass a $1\frac{1}{4}$ -in. ring.

Water shall be clean, free from oil, acid, strong alkalis, or vegetable matter.

Forms.

Forms shall be free from warp, and of sufficient strength to resist springing out

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of shape. All mortar and dirt shall be removed from forms that have been previously used.

The forms shall be well staked to the established lines and grades, and their upper edges shall conform with finished grade of the walk, which shall have sufficient rise from the curb to provide proper drainage; but this rise shall not exceed three-eighths ($\frac{3}{8}$) of an inch per foot, except where such rise shall parallel the length of the walk.

Forms shall be thoroughly wetted before any material is deposited against them.

Size and Thickness of Slabs.

Slabs shall not contain more than 36 square feet or have any dimension greater than six (6) feet, except as hereinafter provided.

Where a greater slab area is desired, a maximum area of 625 square feet is allowed, when the slab is reinforced with $\frac{1}{4}$ -in. bars in both directions, at least every nine (9) inches, or their equivalent. *and*

The minimum thickness of slabs shall not be less than four (4) inches.

Sub-Base.

The sub-base shall be thoroughly rammed, and all soft spots removed and replaced by some suitable material.

When a fill exceeding one foot in thickness is required, it shall be thoroughly compacted by flooding and tamping in layers of not exceeding six (6) inches in thickness, and shall have a slope of not less than one to one and a half.

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The top of all fills shall extend at least twelve (12) inches beyond the sidewalk.

While compacting, the sub-base shall be thoroughly wetted and shall be maintained in that condition until the concrete is deposited.

Base.

The concrete for the base shall be so proportioned that the cement shall overfill the voids* in the fine aggregate by at least five (5) per cent, and the mortar shall overfill the voids in the coarse aggregate by at least ten (10) per cent. The proportions shall not exceed one (1) part of cement to eight (8) parts of the fine and coarse aggregates.

When the voids are not determined, the concrete shall have the proportions of one (1) part cement, three (3) parts fine aggregates and five (5) parts coarse aggregates.

* To determine voids, fill a vessel with sand and let net weight of sand equal B. Fill same vessel with water and let net weight of water equal A.

$$A \times 2.65 - B$$

$$\text{Per cent voids} = \frac{\quad}{A \times 2.65} \times 100$$

This formula may also be used in determining voids in crushed stone and screenings by substituting for 2.65 the specific gravity of the stone.

The following is a more simple method for determining voids in coarse aggregate. Fill a vessel with the aggregate and let net weight equal B. Add water slowly until it just appears on the surface and weigh. Let net weight equal A. Fill same vessel with water and let net weight equal C.

$$A - B$$

$$\text{Per cent voids} = \frac{\quad}{C} \times 100$$

Use a vessel of not less than one-half ($\frac{1}{2}$) cubic foot capacity. The larger the vessel, the more accurate the result.

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A sack of cement (94 pounds) shall be considered to have a volume of one (1) cubic foot.

Mixing.

The ingredients of concrete shall be thoroughly mixed to the desired consistency, and the mixing shall continue until the cement is uniformly distributed and the mass is uniform in color and homogeneous.

(a) *Measuring Proportions.* Methods of measurement of the amounts of the various ingredients, including the water, shall be used, which will secure separate uniform measurements at all times.

(b) *Machine Mixing.* When the conditions will permit, a machine mixer of a type which insures the proper mixing of the materials throughout the mass shall be used.

(c) *Hand Mixing.* When it is necessary to mix by hand, the mixing shall be on a water-tight platform and especial precautions shall be taken to turn the materials until the mass is homogeneous in appearance and color.

(d) *Consistency.* The materials shall be wet enough to produce a concrete of such a consistency that water will rise to the surface of the mass under light tamping, and, on the other hand, one that can be conveyed from the mixer to the forms without separation of the coarse aggregate from the mortar.

(e) *Retempering.* Retempering mortar or concrete, *i. e.*, remixing with water after it has partially set, shall not be permitted.

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Placing of Concrete.

(a) *Methods.* Concrete after the addition of water to the mix shall be handled rapidly to the place of final deposit, and under no circumstances shall concrete be used that has partially set before final placing.

(b) *Freezing Weather.* Concrete shall not be mixed or deposited at a freezing temperature unless special precautions are taken to avoid the use of materials containing frost or covered with ice crystals, and in providing means to prevent the concrete from freezing after being placed in position and until it has thoroughly hardened.

Walks shall be laid in such a manner as to insure protection of the pavement from injury caused by change in the foundation or by contraction and expansion.

Workmen shall not be permitted to walk on freshly laid concrete, and where sand or dust collects on the base it shall be carefully removed before wearing surface is applied.

Wearing Surface.

The wearing course shall have a thickness of at least one (1) inch.

Mortar for this course shall be mixed in the same manner as the mortar for the base, but in the proportion of one (1) cement to two (2) of fine aggregate, and it shall be of such consistency as will not require tamping, but will be readily floated with a straight-edge.

The wearing surface shall be spread on the base immediately after mixing, and in no case shall more than fifty (50) minutes

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elapse between the time that the concrete for the base is mixed and the time that the wearing course is floated.

After being worked to an approximately true surface, the slab markings shall be made directly over the joints in the base with a tool which shall cut clear through to the base and completely separate the wearing courses of adjacent slabs.

Slabs shall be rounded on all surface edges to a radius of not less than one-half ($\frac{1}{2}$) inch.

When required, the surface shall be troweled smooth.

On grades exceeding five (5) per cent, the surface shall be roughened. This may be done by the use of a grooving tool, toothed roller, brush, wooden float or other suitable tool; or by working coarse sand or screenings into the surface.

Where color is used, the quantity and quality shall be such as not to impair the strength of the wearing surface.

Color shall be added in such a manner as to insure a uniform tint.

The application of neat cement to the wearing surface in order to hasten the hardening is prohibited.

Single Coat Work.

Single coat work shall be composed of one (1) part of cement, two (2) parts of fine aggregate and three (3) parts of coarse aggregate, and the pavement shall conform in all respects to the specifications for two-coat work.

The concrete shall be firmly compacted by tamping and evenly struck off and smoothed

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to the top of the form. Then, with a suitable tool the coarser particles of the concrete shall be tamped to a depth which will permit of finishing the walk as under "Wearing Surface."

Protection.

When completed, all walks shall be kept moist and protected from traffic and the elements for at least three days. The forms shall be removed with great care, and upon their removal the edges of the walk shall be protected in a suitable manner.

Curb and Gutter.

For curb, the trench shall be excavated to a depth not greater than the required bottom of the curb and a width not greater than the required width of the curb plus six (6) inches. The minimum thickness of the curb shall not be less than six (6) inches. Concrete shall be deposited at one operation and firmly tamped to within one (1) inch of the top of the forms. The wearing surface shall then be placed only where the curb is to be exposed, of the same composition as that specified for sidewalks.

Joints shall then be made three-quarters ($\frac{3}{4}$) of the total depth of the curb continuous with those in the sidewalks, and in no case more than six (6) feet apart. The forms shall be removed as soon as practicable, when the surface shall be finished at one operation.

Combination curb and gutter shall be formed and finished, where required, at one operation.

W. W. SCHOULER, CHAIRMAN.

43 Clinton St., Newark, N. J.

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How to Select Your Cement.

For the successful manufacture of concrete for sidewalks, or for any other work, it is obvious that the selection of the proper cement is of prime importance. There are at least twenty-five or thirty brands of cement on the market which in their process of manufacture are made to conform to the standards of the American Society for Testing Materials, and the sidewalk maker is safe in making use of any of them. Sidewalks are subjected to heavy wear and it is necessary that they should be made of good, honest material in every part, if they are to wear well.

Portland cement must be "sound." That is, it must be composed of the right proportions of silica, lime and alumina and the mass must be properly burned. When the surface of the concrete begins to break out into bubbles or blisters and the mass undergoes disintegration, it is too late to do much with the sidewalk. Free lime in the cement is a pretty sure cause of this sort of trouble, but it does not make its presence known at once. It is protected from the action of moisture by the clinker of the cement and it is only when it is impossible to remedy

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the trouble that the lime combines with moisture, and trouble begins. It pays from start to finish to deal with a reputable firm of cement manufacturers, one that has a reputation to make or sustain and that is manufacturing in such quantities that it is not sent immediately from the kilns to the market. That is, a firm whose cement is manufactured in large quantities is drawing from a sort of reserve stock of "aged" product that makes for the best results in all kinds of concrete work.

Cement should be carefully ground, and the standard specifications of the American Society for Testing Materials make a special point of this important matter. Under specifications of this organization, it is required that cement on being sifted shall leave a residue of not more than 8 per cent on the No. 100 and not more than 25 per cent on the No. 200 sieve.

The American Society for Testing Materials has determined upon its specifications only after exhaustive tests and the requirements for cement called for by them are within the bounds of experience and practicability. It is safe to say that any cement meeting these requirements is satisfactory in use. Therefore, it is well to be satisfied that the cement you are buying conforms to these specifications. It is important to secure proper cement at the outset.

The time of setting is also an important factor, and a cement should be selected that does not set too quickly. Those brands which get their final set in from four to nine hours are to be preferred to those which set more rapidly. When a cement

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sets quickly, it is usually a sign that there is too much clay in it and that it is deficient in the elements that make for strength. A cement, for example, that sets in thirty minutes almost never develops the strength possessed by a cement that sets in the time mentioned above.

Good sidewalk cement should, however, *harden* promptly. In other words, it should have completed its final set within a comparatively short time. Once the final set is achieved, the hardening process begins and it is believed that this process continues indefinitely over a long term of years. The ideal cement should therefore be slow-setting and *quick*-hardening.

First of all, then, in planning for your sidewalk equipment, make it a point to secure a Portland cement that is sound, seasoned, finely ground, slow-setting and quick-hardening. Have the man from whom you buy your supplies satisfy you on these points, for they are important. If your cement meets all these requirements, you will have taken the first step toward preventing trouble of various kinds.

Sand.

First and foremost, sand must be clean and free from all loam, dirt and dust. Material ideal in other respects, if dirty, will prevent the manufacture of good concrete. Where it is possible to obtain it, sand with sharp grains is usually preferred to sand with rounded elements. A simple test for determining both the cleanliness of sand and the shape of its grains is to rub the material in question between the hands. The peculiar, "gritty" feel of sharp sand

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and the absence of stain on the palms will be two points in favor of using the sand. A good plan is to cover the sand with water and let it stand for an hour or more. If at the end of this time the sand shows any signs of softening or disintegration, it should be absolutely rejected.

Next to cleanliness, it is important that the sand shall be composed of grains which are well graded in size. There is still some difference of opinion among concrete men as to just where sand stops and gravel begins. It is ordinarily figured that material with a diameter smaller than $\frac{1}{8}$ of an inch shall be called "sand," while "gravel" may run up as high as an inch in diameter. Grains or portions of material with a larger size are classed under the head of "crushed stone."

• In place of sand, where the material is readily obtainable, it is profitable to use crusher screenings. Where these are of hard stone, with the dust excluded, they answer admirably the purpose of the smaller particles of the aggregate. The hardest stones, like granite or trap, are the best suited to use in this connection.

Gravel.

All gravel used in concrete work must, like the sand, be clean and free from impurities. Like the sand, also, it should be well graded in size, so that the grains run from the smallest to the largest sizes mentioned. A reasonable proportion of slightly larger size may be used if the grading is quite uniform.

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Cinders.

In sidewalk concrete the use of cinders as a part of the mixture is not advisable where some other aggregate is handy. Cinders add to the fireproof qualities of floors and arches, but in sidewalks they are of no special value, and if you haven't the right kind they are very likely to be the source of trouble. Where there is lime in the ash, or sulphur, as there is almost invariably, the surface of the walk will become pitted. Where it is necessary to make use of cinders get them free from unburned coal, and use about 25 per cent extra of sand to fill the higher percentage of voids. Limestone screenings make good concrete for sidewalks, but the greatest care must be taken to get screenings free from the fine dust or flour that is almost always found in them as they come from the crusher. This crusher dust is the one big cause of failure of concrete made of limestone screenings.

Crushed Stone.

What has been said of gravel applies with equal force to the selection of crushed stone. Since the strength of concrete depends on the hardness of the materials of which it is composed, it is obvious that the strongest material makes the strongest concrete.

The general theory of making strong concrete is based upon having the material of sizes so graded that the smaller particles fill the spaces between the larger ones. Under ideal conditions, there would be no spaces at all. The particles of sand would fill the

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spaces between the particles of gravel or crushed stone and the cement in turn would fill the spaces between the particles of sand. The best concrete results when every separate grain of sand is covered with cement, so as to make a mortar, which in turn covers each particle of the aggregate and binds the whole mass strongly together.

Water.

Water for use in the manufacture of good concrete must be clean and pure, in that it is free from alkali, sulphur, iron or discoloration. The water serves an important purpose in setting up the chemical action of crystallization in the cement, without which it does not harden. The presence of impurities of any kind in the water results in discoloration of the sidewalk, while dirt, dust and so on, may have the effect of forming a thin film between the lower and the upper coat, with the result that they will not bond together. A soft water, clean and clear, used not too cold, will give the best results.

Mixing.

Cement sidewalks are ordinarily made in two sections, a bottom and an upper coat. Where gravel is to be used in the lower coat, the proportion should be one part of Portland cement to four parts of clean, hard gravel, with graded sand enough to fill the voids in the gravel. An average rule for the amount of sand would be to use one-fourth as much of this material as gravel, so that the bottom coat is made up of one part of cement to five of aggregate.

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If crushed or broken stone is used instead of gravel, it is best to use one part of Portland cement, two parts of clean, sharp sand and four parts of broken stone. The larger quantity of sand is used because of the larger number of voids to fill.

Manipulation.

The gravel or stone should be spread out in a layer on the mixing platform or in a shallow box, covering it with the sand, also in a layer, and afterward with the cement. If this dry mass is cut through from the top to the bottom, a uniform mix will be assured. The mixing should be thorough and the mass should be well turned over at least twice before any water is added.

Water is put in in small quantities, from a hose with a spray or sprinkler attachment, and the mass is manipulated until it is of the desired consistency. This is such that the mass looks and acts like a stiff jelly, but it should stand up well after it is tamped into place.

Another method that has many advocates is to spread the sand out first, covering it with the cement, and mix the two until the consistency of the mass is uniform—that is, until the cement is thoroughly distributed through the sand. Then add water in the form of a spray until the mass is plastic. It may now be spread out on the platform or bottom of the box and the coarser aggregate, previously well moistened, added. The mass is then thoroughly turned at least twice, when it is ready to place in the prepared site of the walk.

Water may be added by the pailful or in any other way by means of which it may be

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conveniently measured; but it is important that it shall not be dashed violently into the mixture.

As a general proposition, it is best not to make up more than a cubic yard of concrete at any one time, in order to secure thorough mixing of the batch. The fresh concrete may be transported to the sidewalk site in wheelbarrows, and a good test of the proper consistency of concrete is that it does not "quake" after it is loaded into the barrow.

A small batch mixer, run by a gas or gasoline engine, and having a capacity of one cubic yard, is a saver of time and labor in the preparation of concrete, where any considerable amount of sidewalk is to be laid. There are a number of these mixers on the market, and the man who is going into the business of laying walks will do well to investigate their merits.

Preparation of the Site.

The location of the walk once being determined, the site should be carefully staked off, running the lines such a distance apart that the distance between them is four inches wider than it is desired to make the finished walk. All roots of trees and other wood or material liable to decomposition should be carefully removed. So should all large stones, pieces of sod or turf, and other obstructions to a clear excavation. Where soft spots are uncovered in the process of excavation, they should be filled in with solid material, properly tamped to a good bearing surface.

The heaving and throwing of walks, so often attributed to tree roots growing up

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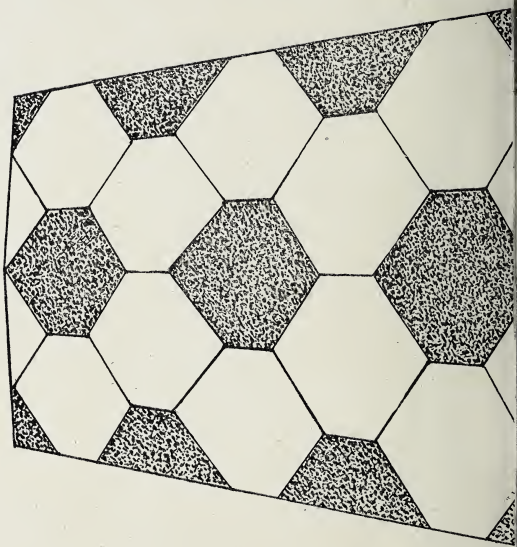
under the walks, is more often the result of the movement of the earth caused by the swaying of near-by trees. Roots, however, do grow close to the stone, as they find moisture there, and elm and maple roots should be looked after especially, as they are likely to cause the most trouble.

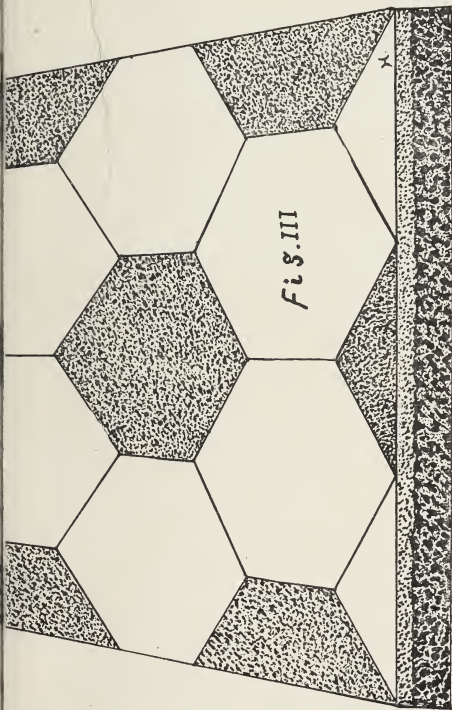
Sub-base.

No deep excavation for sidewalk foundations is necessary, except in very extraordinary cases. The practice of excavating a trench a foot deep and then filling in eight inches or so has been almost universally dispensed with, and with excellent results. It will generally be found satisfactory to remove the sod and top soil to a depth equal to that of the finished walk, as planned. In what little foundation work is done it will be found advisable to tamp in thin layers, thus giving a more solid base for the concrete.

In the excavation should be placed a foundation of sand and broken stone, or gravel, with the sizes well graded, so that when tamped it presents a hard and uniform surface. Where ashes or cinders are used in this foundation and it is laid so as to be porous, agricultural tile should be laid to drain off any water which might otherwise accumulate and freeze, with resultant damage to the walk.

The foundation should be thoroughly moistened, to the same extent as the fresh concrete, before the latter is laid upon it. This should be dumped in and tamped down to a thickness ranging from four to six inches, according to location and specifications required. As soon as the bottom





Hexagonal Sidewalk Built with a Home-made Device. See page 30.

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coat is tamped, and before it has had time to set, the top coat must be added.

Tools.

Devices of various shapes are on the market for the use of sidewalk workers. These consist of rollers, jointers, groovers, edgers, tampers, trowels, floats, and so on. They are practically essential to securing a neat finish and appearance. Care should be exercised in the selection of tools, for there are some on the market which will not stand the strain of continued use.

Curing and Protection.

As soon as the walk is completed, it should be carefully moistened and kept under cover from wind and sun for at least three days. In hot weather the walks should be moistened in the morning and the evening, when the sun is not too hot. This practice prevents the cement from drying out too fast, with resultant weakening and bleaching. General practice recommends the erection of a canvas screen over and around the work, the material being set on a slant, so as to drain rain-water off.

If the walk is laid in freezing weather, warmed materials are essential. The water must be at least lukewarm and the sand and gravel or stone free from frost. For protecting the work from injury by cold, different contractors use different means. Paper, sawdust, sand, shavings and even manure are used to cover the work and protect it. Tar paper is also utilized. It is recommended that the covering be permitted to remain on work laid in freezing weather for at least three weeks.

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Cost of Walks.

It is naturally somewhat difficult to give any definite figures for the cost of sidewalk construction which will continue in force for any length of time. The prices of material and labor vary so much in different sections of the country and at different times that what is a fair price in a city one season may be too little the next. L. L. Bingham, in a paper published in CONCRETE, gives the results of a large number of replies to inquiries that he sent out. He estimates the cost of cement at \$2.00 per barrel, and on that basis concludes that the cement cost per square foot is $33\frac{1}{2}$ cents. The square foot labor cost he places at $2\frac{1}{2}$ cents. Expenditures for incidentals, like forms and stakes, coverings, tools, mixing platforms and boxes, interest, and so on, bring the cost per square foot up to about 8 cents. Prices obtained range from 8 cents to 16 cents, averaging about $11\frac{1}{2}$ cents.

Estimating on Work.

One barrel of Portland cement, is it estimated, will lay about 60 square feet of walk, five inches thick at the middle and four inches thick at the edges, six feet wide, when mixed in the proportions suggested in foregoing paragraphs. Knowing the cost of sand, gravel and labor, the sidewalk maker can form a fairly good idea of what the walk is going to cost him to lay and what he ought to charge for it in order to make a fair profit. Good walks are the best advertisement, and a neat nameplate, set into the surface of the finished

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walk, is an excellent business card. The man who makes a reputation for walks that look well and wear well will have no difficulty in obtaining a fair price for his work.

Street Crossings.

The foundation for concrete street crossings should be the same as for sidewalks. The base should consist of a layer $4\frac{1}{2}$ inches deep, composed of one part of Portland cement and four parts of clean sand and gravel, thoroughly mixed dry, properly wetted, and tamped to uniform grade. The surface should consist of a layer $1\frac{1}{2}$ inches thick, composed of one part Portland cement and $1\frac{1}{2}$ parts of good, clean, sharp screened sand, thoroughly mixed when dry and wetted to a consistency of thick mortar. This top surface should be thoroughly troweled into the base and finished to conform with a grade established by the city engineer.

Curbing.

After excavating to a proper depth, set frames for curbing with spreader board between, not less than four feet apart. Brace frames thoroughly opposite these spreading boards, keeping the outside frame at all times in line. Concrete for curbing should be composed of one part Portland cement to five parts clean, sharp sand and gravel, thoroughly mixed dry and then wet to a proper consistency. After the concrete has been thoroughly mixed, tamp in place, using sheet iron division plates to cut the curbing in sections not less than four nor more than six feet in length. The top

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coat of curbing should be at least $\frac{1}{2}$ " in thickness and should consist of one part of Portland cement to two parts of clean, sharp, screened sand, and should be thoroughly smoothed off with a trowel on the edges and finished to its desired shape with an edger or curb tool.

For business streets, curbing should be from 18" to 22" deep and 5" in thickness at the top and 7" at the bottom. For residences curbing may be 14" or 16" in depth, but of no less thickness than for street curbing.

There has been a great deal of discussion as to whether it is best to put the curbing on a business street outside of the walk or let the walk rest on the curbing. Experience has shown the latter method to be preferable; that is, let the walk rest on the curbing. This allows the walk to slide back and forth on the curb as it expands and contracts without disturbing the curb, while if it is placed outside the walk the expansion of the walk may displace the curb.

Reinforced Sidewalks.

If necessity requires that a sidewalk shall be built in such a location that the supporting soil is likely to be washed from beneath it, reinforcement is an excellent precaution. We have in mind such walks as are sometimes built on sandy soil, in locations liable to attack from unusually high water. If the sidewalk builder will lay a mesh of expanded metal, the width of the walk, and about two inches from the lower level of the bottom coat, he will have a construction that will at least support its

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own weight until such time as the underpinning can be replaced and tamped to a solid bearing surface. A six-inch mesh should be ample for all ordinary purposes.



Hints and Suggestions.

Do not attempt to use a mixture of concrete after the set has begun.

Avoid the use of sand that is too fine. If you use it, you will have trouble.

Moisten the coarse aggregate well before adding the cement. It assists the cement in adhering to the particles.

Don't scatter Portland cement on the surface of your finished work. If you do, you will have difficulty at that particular point.

In preparing the excavation for a cement sidewalk, absolute drainage is essential, if trouble from freezing water, with consequent expansion, is to be avoided.

Shade trees should be set not less than four feet from the walk and in the case of trees whose roots run close to the surface of the ground, a distance of ten feet is still better.

Union between the top and the bottom coat is best accomplished by tamping them together. Have enough water so that the air in the cement will escape when the tamping is done.

Be sure that your bottom coat is still moist and fresh when the top coat is applied. Otherwise, the two will not join. Be careful, too, that no dust or dirt is lying on the bottom coat, or you will fail to get a bond.

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A barrel of cement will give, in the proportions of one part of cement, $2\frac{1}{2}$ sand and 5 gravel for the bottom course, and three of sand to five of cement for the top course, 25 square feet of walk eight inches thick and 55 square feet of walk five inches thick.

Some walk-makers sprinkle thoroughly slacked lime that has been finely ground, on the surface of the walk before it has begun to harden. This practice tends to delay the set a little and also produces a good color effect. Lime that has been prepared in this manner, added to the cement used in the top dressing or coat, will whiten the walk and assist in shedding the water.

Finish the walk while the upper surface is still moist and easily worked. Avoid too much use of the trowel. In the action of this tool, a vacuum is created between the surface of the walk and that of the trowel, with the result that particles of neat cement are drawn to the surface, where they dry out and are worn off, with the result that the top coat is robbed of its proper proportion of cement. If the walk is finished after it has begun to set, the resulting surface will be brittle. It will crumble easily.

Where broken brick and cinders are used in filling in the excavation, it is wise to tamp them as solidly as possible and to cover them with a layer of sand in order to prevent opposite action in expansion from freezing. One contractor explains the action of frost in cracking walks by saying that the ground expands, owing to the action of the freezing water, while the hardened cement contracts from the cold. The

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two forces act in direct opposition, so some means should be taken to prevent the subsoil from freezing to the lower surface of the walk. Careful provision for drainage will avoid this danger.

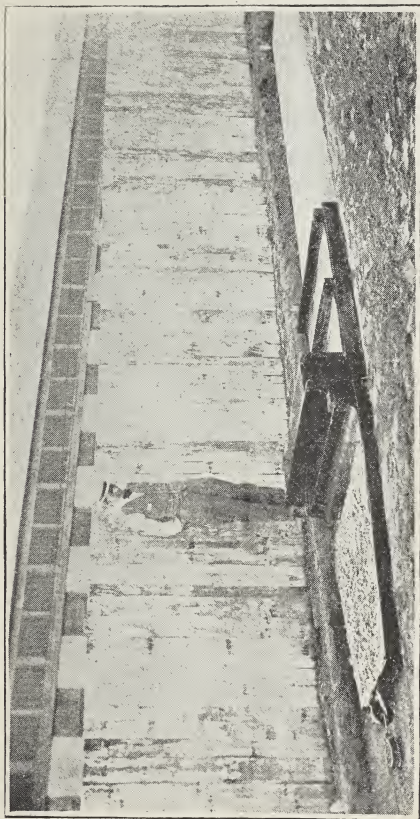
Albert Moyer, a sidewalk expert, suggests the advisability of making the entire walk a uniform slab of closely compressed, carefully selected stone. Just before the surface dries, he advocates scrubbing it with a wire brush, of the kind used in cleaning boilers. A gentle stream of water played from a hose in the path of the brush will assist in removing the thin skin of neat cement which gives the walk its original neat finish, but which in time wears off under traffic. For walks in which appearance is not the first consideration, this suggestion is an excellent one, as it produces a walk of first-rate wearing qualities.

A Molding Machine for Building Cement Sidewalks.

We illustrate herewith a machine that is said to lay and finish cement sidewalks with great rapidity. It consists of a traveling mold and a winch for pulling the mold ahead. Concrete for the base of the sidewalk is shoveled into the front part of the mold, and the finishing mortar is placed in the hopper at the middle of the mold. This hopper is so designed that it feeds a thin layer of mortar onto the concrete base as the mold travels forward. Thus a completed sidewalk is delivered at the rear end of the machine.

No skilled finishers are required. No labor is needed to build forms. No men

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A Machine that Builds Sidewalks.

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are needed to tamp the concrete. The process is simply one of mixing the ingredients and depositing them in the proper part of the traveling mold. The mold does the rest.

With a properly organized gang, the mold is kept traveling continuously at the rate of two feet per minute. The shape of the mold is such that the concrete is squeezed both laterally and vertically into a dense block, which requires no ramming. Perhaps the most remarkable feature of the mold is the perfect finish that it gives to the sidewalk. The walk shown in the illustration looks as if it had been hand-finished with floats.

While this device is intended primarily to build sidewalks in place, it may be used to build slabs of concrete, which may be taken up and laid like flagstones. If desired, the concrete may be reinforced with steel rods or with expanded metal or wire mesh.

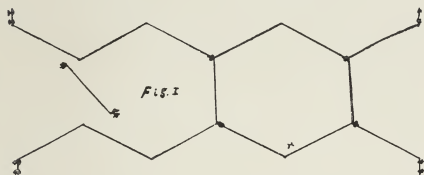
This sort of a mold could be used also for making cement lintels, coping, fence posts, railway cross-ties, and a multitude of concrete structures having a uniform cross-section.

How to Make Sidewalk Tile.

With the present method of building sidewalks of different colored hexagonal blocks, a vast amount of labor is required to mold the different blocks and set them in the walk, and expensive machinery is used for this purpose.

With the simple, rapid and effective machine described below the builder may lay the foundation of the walk as usual, and

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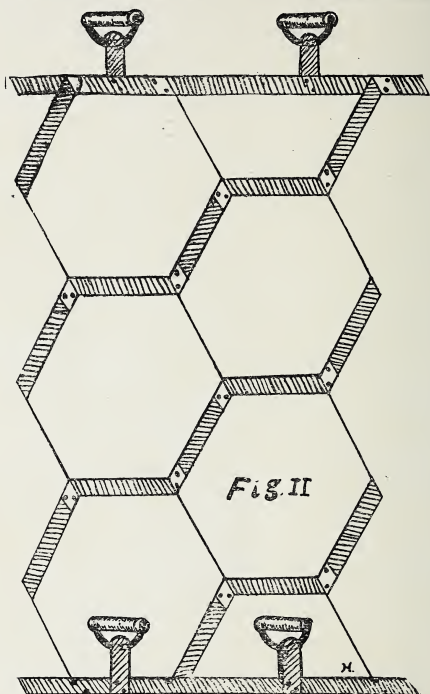
five inches beyond the point of riveting and by simply setting the machine in place for each square and filling the spaces with the different colors of concrete mixture, mold an entire section of perfectly formed hexagonal blocks at one operation. This requires but very little more time than is necessary to lay a plain walk.

To make the machine, three pieces of one-eighth or one-fourth inch iron strips, two inches wide and seventy-one and one-half inches long, are required. At each end, these are bent upward two inches and holes are drilled in them for rivets; they are now bent as shown in Fig. I., with the points of bending exactly eleven and one-fourth inches apart, and at an angle of about 40 degrees. These make the three center parts of the machine as shown in Fig. II.

Five strips are now cut fourteen inches long from the same size iron and bent two inches at each end, through which holes are drilled for rivets; these are riveted to the three center parts of machine as illustrated in Figs. I and II, and form an hexagonal mold that is exactly twenty inches across at its two widest points.

To the sides of these, strips of the same sized material forty inches long are riveted as shown in Fig. II. These strips project

CEMENT SIDEWALKS



so are at the ends of same in exact line with the widest points of the center strips, and form the sides of the walks as fast as laid.

To the two side strips of iron four handles are riveted, as shown in Fig. II, to make the device easy to handle,

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How It Works.

In operation, the base of the walk is laid, the machine is set upon it, the spaces filled with the different colors of concrete desired, and the top leveled off. The machine is then lifted and set upon the next space, and the edges of the hexagonal blocks finished with the pointing trowel; during this operation any small particles of mortar that lift with the machine may be pressed back into place, making each block perfect in shape and color.

The machine as illustrated will mold a section of walk five feet wide and forty inches long. This length may be increased by adding more sections, which may be fastened together if desired, but by having the machine so that it can be easily handled by two men the work will be more rapid and is more neatly done.

For walks of a width greater than five feet, the length of the centers may be easily increased to make the mold of the proper width; or two sections may be set side by side when walks of ten-foot width are constructed.

In Fig. III a section of the walk constructed with this machine is shown. This gives you an idea of the method of using the two colors of concrete, as well as the appearance of the finished walk.

This style of sidewalk has one big advantage over the plain square sections, as each section is separate and distinct, and while it is all laid at the one operation, this one feature removes all danger of cracking by the freezing of the soil under the walk, as well as the trouble sometimes caused by

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the roots of trees. The walk has every chance to adjust itself to these conditions without causing unsightly cracks in the blocks or sections.

Again, this style of sidewalk will command a much better rate than the plain sections, and with the aid of this simple machine can be built at very little additional labor and expense.

Dividing Plates for Expansion Joints.

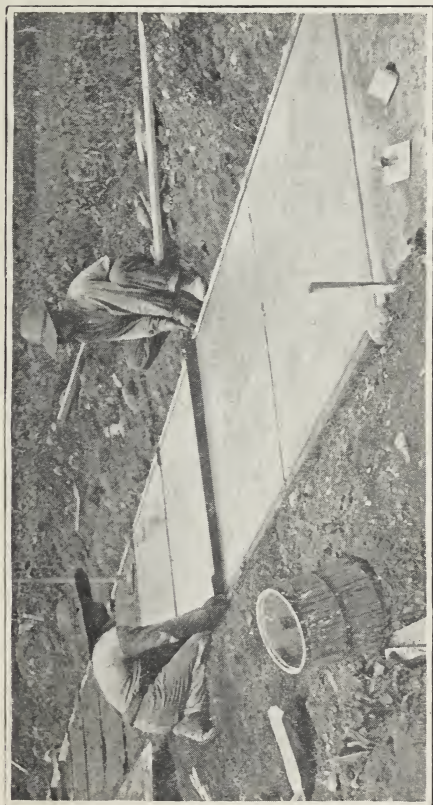
Expansion joints, as has been stated, are always important, and any device that lessens the laborer's work, or makes a neater job, or both, is worthy of attention. There is on the market a sidewalk form, consisting of tie and dividing plates, illustrated herewith, that is said to be very successful as a time and labor saver.

Common 2x4's are used as side rails and steel dividing plates tie the two side rails together, the steel plates hooking onto the 2x4's where they are secured by wedges. These plates are $\frac{1}{4}$ " thick, and in addition to forming the expansion joints, they brace the whole form and render the use of stakes unnecessary, except for grade lines. After the walk has begun to set, the plates are withdrawn, and the edger used to round off the sides of the section. If the plates are kept clean they withdraw easily, without tearing or disturbing the concrete. The device is patented by Zeiser Bros., sidewalk contractors of Berwick, Pa., and has been used quite extensively in the East.

Cellar Floors.

In laying cement floors the methods differ somewhat from those employed in side-

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Withdrawing the Dividing Plate.

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walk construction. Owing to the fact that the cement is not exposed to the action of wind and weather, there is a great deal less expansion and contraction, and in floor work under shelter, expansion joints are dispensed with.

For ordinary cellar floors, a layer of concrete not less than $1\frac{1}{2}$ " thick, over a 4" bed of cinders, is generally sufficient. The concrete should be mixed in the proportion of 1:3, with bank-run sand and gravel, and floated to a level.

Drainage is an important point to consider in cellar work, and where floors are to be laid on clay, sub-drainage, with tiles or otherwise, should be provided.

Repairing Plank Walks.

It often becomes necessary under a city ordinance to build a new wooden walk when the old plank are perfectly good, on account of the stringers being too rotten to hold a nail. This expense can be avoided by putting in a concrete stringer without disturbing the plank. To do this, dig a small trench under each side of the walk, extending about 4" under and about 4" deep; drive spikes into the plank about 2" from the edge of the walk, so as to extend down into the trench. Then fill the trench with concrete, tamping it up to the plank. If the plank are warped up at the end, weight them down until the nails are firmly set in the concrete stringer. This will insure you a foundation that will outwear your plank. Should there be any holes in the walk, cut out the rotten wood, fill in the cavity (if more than 3" deep) with cinders well

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tamped; then fill with concrete to the surface. At a very small cost, an old walk may in this way be kept in repair for years.

Concrete Floor Over Wood Floor.

Many times it is desired to replace an old wood floor with one of concrete. This can be done by laying the new floor over the old. In preparing for this, examine all the joists well, nail down all loose boards, and during the construction and curing of the work, shore up all weak spots that may manifest themselves. Lay on the floor expanded metal or heavy wire cloth of not over six-inch mesh, tying down the ends with light wire staples. The strips should overlap one another about three inches. Wet the floor thoroughly.

Upon this, lay a course of concrete about $1\frac{1}{2}$ " thick, except on driveways, where it should be $2\frac{1}{2}$ " thick. Lay the floor in 4' strips, returning after each operation and finishing that strip with a wooden float after leveling with a straight-edge. Repeat this operation the entire length of the floor. Be careful not to fracture the floor after the process of crystallization has started. This accident is likely to be caused by springing some of the boards adjacent to the newly-laid concrete.

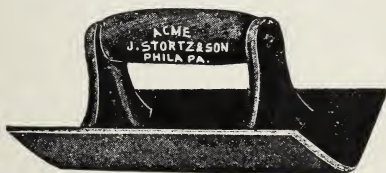
The mixture should be 1 part Portland cement to 3 parts bank-run sand and gravel, to be laid in one continuous layer. Gutters may be formed where necessary. This process will be found valuable in repairing old barn floors and has been used with great success in any number of instances.

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